

the plot of raw output versus pulses at least one day prior to the failure.

Conclusions: Energy variations of Tomo HD can be monitored by Exit Detector Flatness in the TQA software. Abnormal waveforms from raw output can be observed before a magnetron failure in more than half of the cases.

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DVHs evaluation for vmat-imrt planning in cylindrical phantom DELTA4

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Purpose/Objective: 3D dose and dose volume histogram (dvh) calculation is a new option of the delta 4 phantom for pre-treatment verification; dose deviation can be rated differently depending on where it occurs: in a target, in an organ at risk or in a non critical structure. For example an under dosage in an organ at risk should not trigger a fail-indication whereas a similar under dosage in a target definitely should trigger a fail indication. The purpose of this study is to evaluate the Dose volume histograms of 250 patients measured with Delta 4 diode array Phantom (Scandidos), grouped per pathology and tumor site and to find some new acceptance criteria based on clinical significance.

Materials and Methods: 250 patients were treated using VMAT arc delivery for various tumor sites; all treatments were planned with Elekta Monaco planning system (ver. 3.2) and delivered on an Elekta Synergy (40x40 cm² field size without interdigitation) or on an Elekta Axesse (21x16 cm² field size with 0.4 cm leaves with full interdigitation). Each treatment plan was then measured using Delta 4 diode array cylindrical phantom. First all measurements were compared to the treatment planning system dose distribution via gamma analysis (3 % dose difference, 3 mm distance to agreement criteria). The presence of the carbon fiber couch was taken into account. The software of the Delta 4 defines ROI inside the phantom that are identical to the imported patient structures regarding shape and position towards the isocenter, therefore dvhs were calculated inside the cylindrical homogenous phantom for planned and measured 3D dose distribution. The patients were divided into nine groups according to tumor site (anus, head&neck, snc, liver, lung, lung sbt, rectum, prostate, mediastinum) and, for each site, the most critical organs at risk were selected. We compared dvhs parameters such as V95% and V107% for PTV, D1 for spinal cord, median dose for parotids and so on for the dose calculated and measured.

Results: In the table is shown the result of the gamma analysis for all patients. If $\Gamma(3\text{mm}, 3\%) = 90\%$ is a reasonable cutoff for accepting the plan, we found 14% of the patients having a gamma value less than acceptance criteria. Performing the dvhs analysis for these patients, comparing calculated and measured parameters, we found a discrepancy between values of the most critical organ at risk more than 5% only in 4% of the all patients; for these patients, we have definitively rejected the plan.

	DTA Γ 3% 3mm	Γ 5% 3mm
mean	96.6	93.8
Dev st	7	7
	4.7	

Conclusions: One of the main benefits in making pre-treatment verification based on 3D and dvhs data is that acceptance criteria might be based on clinical significance: you can evaluate if the discrepancy between measured and planned dose is in a critical organ or if it is in the healthy tissue. We propose a selection criteria based on the evaluation of the gamma index of the dose distribution and the % difference of the constraints between calculated and measured plan.

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Dose distributions in radiotherapy of patients with titanium and resorbable implants

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Purpose/Objective: The investigation was performed in order to compare radiotherapy dose distributions in tissues surrounding the titanium or resorbable implants used clinically for joining and consolidating of the facial bones. Inhomogeneous dose distributions can be a reason of the normal tissue complications observed during the radiotherapy of patients after surgery during which the titanium plates were implanted. The knowledge about the distribution of the

dose around the implants would help to decide whether to preserve or to remove the implants before irradiation.

Materials and Methods: The commonly available resorbable implants require comparing them with the titanium implants in case of patients requiring radiotherapy after surgery. The dose distributions around the titanium and around the resorbable implants were measured and compared. Nucletron Oncentra MasterPlan treatment planning system (TPS) was used for the calculation of the dose distributions. For measurements, Gafchromic EBT radiochromic dosimetry films were used for recording the dose distributions in tissue equivalent phantoms. The phantoms and films were irradiated with 4 MV photon beams of Varian Clinac 600C/D linear accelerator. The irradiated films were digitized with Epson 10000XL flat bed scanner and the dose distributions were compared using 3Cognition FilmQA software.

Results: The dose measured on the contact surfaces between the titanium implant and the phantom material proximal and distal to the beam source at depth of 2.5 cm were 109% and 92% of the reference dose measured in homogenous tissues without the implants, respectively. For the resorbable implants the doses measured on the proximal and the distal contact surfaces were 102% and 101% of the reference dose respectively. An interaction of ionization radiation with the titanium reconstruction plates is widely discussed in the literature. The distortions of the homogenous dose distribution around the implants appear only at the distance of few millimeters, but this is often more than the thickness of the normal tissue or even the tumor in that localization. Clinically, the risk of complications should be regarded in form of early or late complications or recurrent tumors.

Conclusions: The titanium plates significantly affect the homogeneity of the dose distribution and create the underdose and overdose regions. Apart of these effects the presence of the titanium implants during the computer tomography examination creates the image artifacts which may significantly disturb the target volume delineation as well as the early detection of the recurrent cancer in the cavities after surgery. The resorbable implants affect the homogeneity of dose distributions in significantly lesser degree in the irradiated media and their presence does not generate the image artifacts during CT examinations.

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RapidArc independent monitor unit calculations with Diamond. Practical considerations

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Purpose/Objective: At the moment it is recommended to perform an independent check of the MUs calculated by the treatment planning system (TPS). In modern complex treatment techniques it is not feasible to perform these checks by hand, Diamond (PTW Freiburg) is a secondary check software that allows independent MU and point dose verification for conformal and IMRT treatment plans which validation has been already reported in the literature. The purpose of this work is to describe the practical aspects and results in our experience in using Diamond for RapidArc (RA) treatments.

Materials and Methods: Our department has been recently equipped with 3 Varian linacs (with RA) and 6 Eclipse (10.0) TPS stations that are used to calculate dose distributions. As a part of our QC program all the dose calculations are independently checked, in particular our IMRT pre-treatment protocol establishes that prior to each treatment, calculations are verified at least with Diamond software (PTW), Portal Dosimetry (Varian) and Octavius4D (PTW). For the MU/point dose verification Dicom files exported from Eclipse (dose, plan and structure) are imported by Diamond which compares results against the TPS. The isocenter coordinates and dose are automatically read by Diamond to perform the comparison, but if it is not a representative dose point for all the arcs, extra points must be generated in Eclipse and manually introduced in Diamond. We have analyzed the results of the comparisons as well the practical questions that have arisen.

Results: More than 700 plans have been calculated since February 2012, being about 45% RA treatments. Several arcs are commonly used (1-4), 2 for the majority of the plans (65%). The average obtained deviation has been 0.29%, being the maximum found deviation of 8% in a point. The verification takes about 15 minutes to be performed including the time needed to introduce the extra dose points that are not read by Diamond. The main practical drawbacks that we have faced are: the program automatically reads the structures file in order to take into account the patient contour and consequently the depth at each control point of the arc, but when the external contour